

***Anthracoidea kenaica*— a new record from Russia**

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ABSTRACT—A rare smut fungus, *Anthracoidea kenaica* on *Carex micropoda*, is reported for the first time from Russia and Asia, based on a specimen from Karaginsky Island (Kamchatka Territory). This species has been previously recorded only from three localities in the Pribilof Islands in the Bering Sea, the Kenai Peninsula (Alaska), and British Columbia. A description, illustrations, and a distribution map are provided. A list of the known *Anthracoidea* species in the Russian Far East is also given.

KEY WORDS—amphi-Beringian species, *Anthracoideaceae*, Pauciflora Clade of *Carex* subgen. *Euthyceras*, *Ustilaginales*

Introduction

Anthracoidea Bref. is the largest genus of smut fungi on host plants in the *Cyperaceae*, comprising 112 species (Denchev & al. 2020, 2021). It is a cosmopolitan genus, but much more species-rich and widely distributed in the northern hemisphere. The smut fungi in this genus possess sori that form globose to broadly ellipsoidal or ovoid, black, hard bodies around aborted nuts of cyperaceous plants. In *Carex* L., the sori are scattered in female spikes or in female flowers of mixed spikes, depending on the *Carex* species. The species of *Anthracoidea* on *Carex* are host-specific smut fungi restricted to sedges belonging to the same or closely related sections (Kukkonen 1963, Vánky 1979, Denchev & al. 2021).

A specimen of *Carex micropoda* C.A. Mey. infected with *Anthracoidea* from the Russian Far East (Karaginsky Island) was found during a visit to the herbarium at the Royal Botanic Gardens, Kew (K) in May 2010. Only one *Anthracoidea* species, *A. kenaica*, is known on *Carex micropoda*. This smut fungus is a rare species, recorded from only three localities: Saint Paul Island (Pribilof Islands in the Bering Sea), Kenai Peninsula (Alaska), and British Columbia (Savile 1952, as '*Cintractia carpophila* var. *kenaica*'; Zambettakis 1978, as '*Anthracoidea heterospora* var. *kenaica*'; Piątek 2013). The type specimen is from the Kenai Peninsula. A morphological examination of the specimen on *Carex micropoda* from the Russian Far East demonstrated its identity with *Anthracoidea kenaica*.

Thirty-five species of *Anthracoidea* are currently known from the Russian Far East: *A. arenaria* (Syd.) Nannf., *A. arnellii* Denchev & al., *A. aspera* (Liro) Kukkonen, *A. atratae* (Savile) Kukkonen, *A. bigelowii* Nannf., *A. buxbaumii* Kukkonen, *A. capillaris* Kukkonen, *A. caricis* (Pers.) Bref., *A. caricis-albae* (Syd.) Kukkonen, *A. caricis-pauciflorae* (Lehtola) Kukkonen, *A. caryophylleae* Kukkonen, *A. echinospora* (Lehtola) Kukkonen, *A. elynae* (Syd.) Kukkonen, *A. fischeri* (P. Karst.) Kukkonen, *A. globularis* Kukkonen, *A. heterospora* (B. Lindeb.) Kukkonen, *A. humilis* Vánky, *A. intercedens* Nannf., *A. irregularis* (Liro) Boidol & Poelt, *A. karii* (Liro) Nannf., *A. lasiocarpae* B. Lindeb., *A. laxae* Kukkonen, *A. limosa* (Syd.) Kukkonen, *A. lindebergiae* (Kukkonen) Kukkonen, *A. liroi* (Lehtola) Nannf. & B. Lindeb., *A. michelii* Vánky, *A. misandrae* Kukkonen, *A. paniceae* Kukkonen, *A. pilosae* Vánky, *A. rupestris* Kukkonen, *A. scirpi* (J.G. Kühn) Kukkonen, *A. scirpoideae* Kukkonen, *A. siderostictae* Kukkonen, *A. subinclusa* (Körn.) Bref., and *A. variabilis* (S. Ito) Kakish. (Govorova 1987, 1990; Azbukina & al. 1995; Denchev & al. 2010, 2013, 2020; Denchev & Minter 2011). *Anthracoidea kenaica* is reported here for the first time from the Russian Far East and Asia.

Materials & methods

A dried specimen from the herbarium of the Royal Botanic Gardens, Kew (K) was examined under light microscope (LM) and scanning electron microscope (SEM). For LM observations and measurements, spores were mounted in lactoglycerol solution (w : la : gl = 1 : 1 : 2) on glass slides, gently heated to boiling point to rehydrate the spores, and then cooled. The spore measurements are given as min–max (extreme values) (mean $\pm$ 1 standard deviation). The spore length range is in accordance with the groups distinguished by Denchev & al. (2020: 11): very small-sized, small-sized, medium-sized, and large-sized. For SEM, spores were attached to

specimen holders by double-sided adhesive tape and coated with gold using an ion sputter coater. The surface structure of spores was observed and photographed at 10 kV accelerating voltage using a JEOL SM-6390 scanning electron microscope. The description of spore ornamentation is in accordance with Denchev & al. (2013). The description below is based entirely on the specimen examined. The list of shapes of spores is arranged in descending order of frequency.

Taxonomy

Anthracoidea kenaica (Savile) Piątek, IMA Fungus 4: 104, 2013.

FIG. 1

≡ *Cintractia carpophila* var. *kenaica* Savile, Canad. J. Bot. 30: 419, 1952.

≡ *Anthracoidea heterospora* var. *kenaica* (Savile) Zambett.,
Bull. Soc. Mycol. France 94: 177, 1978.

INFECTION local. SORI in some female flowers, around aborted nuts as ovoid, black, hard bodies, 1.0–1.5 mm long, initially covered by a thin greyish peridium that later flakes away exposing a black spore mass, powdery on the surface. SPORES small- to medium-sized, flattened, in plane view suborbicular, broadly elliptical or ovate, in plane view (16–)17–21 (–23) × 13.5–18.5 (–20) ($19.3 \pm 1.1 \times 17.5 \pm 1.5$) μm ($n = 100$), in side view 12.0–15.5 μm thick, middle reddish brown, wall evenly or almost evenly thickened, 0.8–1.2 (–1.5) μm thick, with 1–5 usually conspicuous internal swellings, light refractive areas and protuberances absent, some spores covered by a thin hyaline sheath, in LM smooth, spore profile not affected. In SEM, spore wall punctate, warts <0.1 μm (as measured in SEM). SPORE GERMINATION unknown.

SPECIMEN EXAMINED—On *Carex micropoda*: RUSSIA, KAMCHATKA TERRITORY, Karaginsky Island in the Bering Sea, Mt. Vysokaya, 22 August 1976, leg. S. Kharkevich & T. Buch, Plantae Vasculares Orientis Extremi Rossici, Flora Exsiccata, no. 972d (K, s.n.).

DISTRIBUTION—On *Cyperaceae*: *Carex micropoda*, Asia (Russian Far East) and North America (Saint Paul Island in the Bering Sea, Kenai Peninsula, and British Columbia) (FIG. 1).

COMMENTS—The morphological features given in the protologue of *A. kenaica* (Savile 1952, as '*Cintractia carpophila* var. *kenaica*') are similar to those reported here.

Carex micropoda is an amphi-Pacific/Beringian–Cordilleran species (Elven & al. 2018), distributed in the Russian Far East, Japan, islands of the Bering Sea, and western North American mountains (Egorova 1999, Murray 2002). Based on the current distribution data, *Anthracoidea kenaica* is an amphi-Beringian–Cordilleran species.

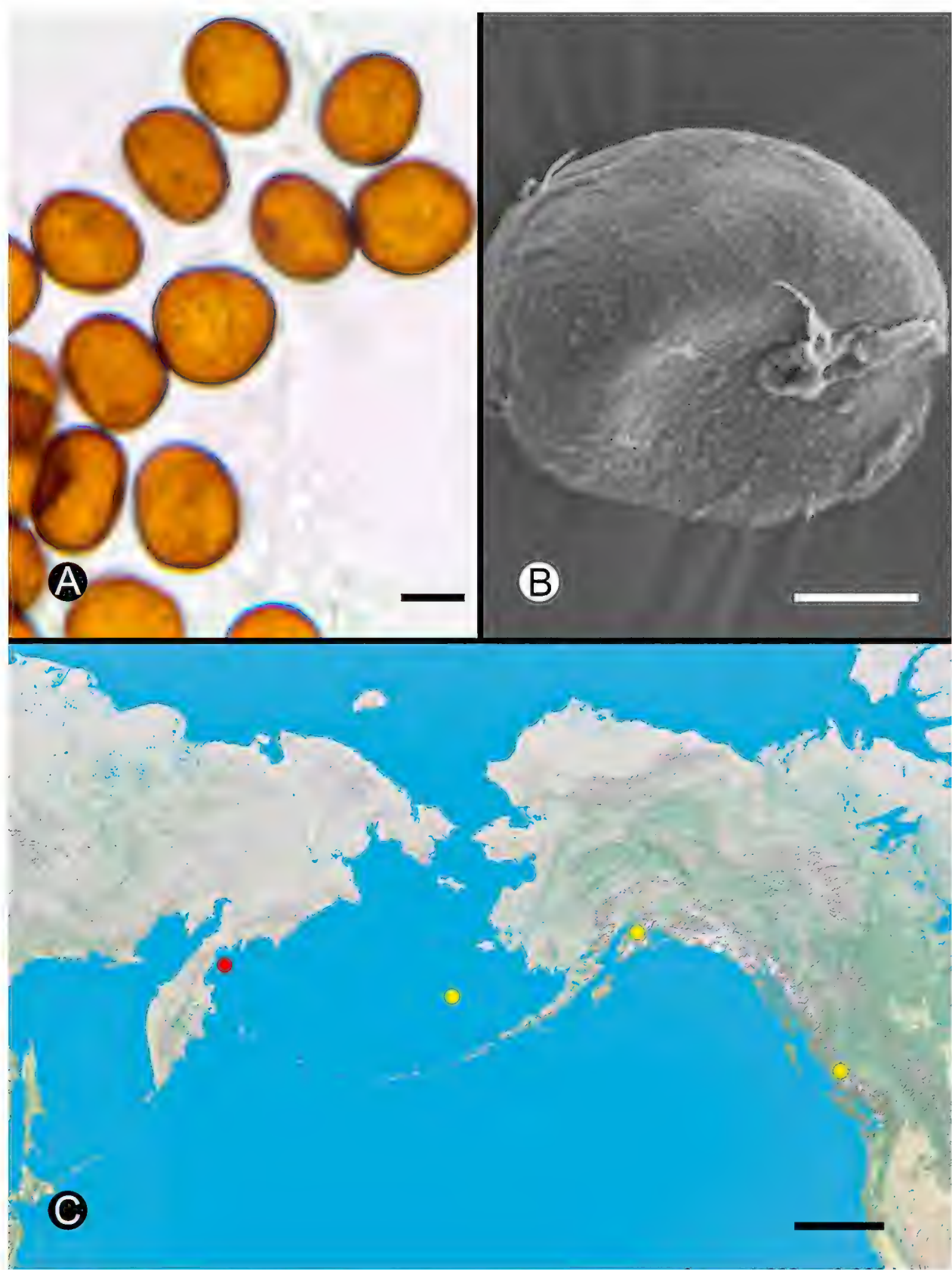


FIG. 1. *Anthracoidea kenaica* on *Carex micropoda* (Pl. Vascular. Orient. Extremi Rossici, Fl. Exs., no. 972d, K): A. Spores in LM; B. Spore in SEM; C. Geographic distribution (red circle = examined specimen, yellow circles = literature records). Scale bars: A = 10 μ m, B = 5 μ m, C = 1000 km.

Carex micropoda has been traditionally included either in *C.* sect. *Callistachys* (Heuff.) Mack. (Egorova 1999) or in *C.* sect. *Dornera* Heuff. (Murray 2002). A recently proposed classification of *Carex* places this sedge within the Pauciflora Clade of *C.* subgen. *Euthyceras* Peterm. (Roalson & al. 2021). The Pauciflora Clade is a heterogeneous group of unispicate sedges that includes the species of the previously recognized sections *Circinatae*, *Dornera*, and *Inflatae*, and the type of sect. *Leucoglochin*, *C. pauciflora* (Roalson & al. 2021). There are 14 sedges in this clade, among which only two species are reported as hosts of *Anthracoidea* species: *Carex breweri* Boott as host of *A. breweri* Salo & Vánky (Vánky 2011a) and *Carex pauciflora* as host of *A. caricis-pauciflorae* (Kukkonen 1963, Vánky 2011b). *Anthracoidea kenaica* differs from *A. breweri* and *A. caricis-pauciflorae* by having (i) smaller spores (small- to medium-sized), $\leq 23\ \mu\text{m}$ long, while *A. breweri* and *A. caricis-pauciflorae* have medium- to large-sized spores ($\leq 27\ \mu\text{m}$ long); (ii) punctate spore ornamentation vs. minutely verruculose ornamentation for *A. breweri* and *A. caricis-pauciflorae*; and (iii) internal swellings, while the spores of *A. breweri* and *A. caricis-pauciflorae* have no internal swellings.

The protologue of *Cintractia carpophila* var. *kenaica* cites a second host plant, *Carex deweyana* Schwein. (Savile 1952: 420). The smut fungus on *C. deweyana*, however, possesses minutely verruculose spores and was later described as a distinct species, *Anthracoidea deweyanae* Denchev & T. Denchev (Denchev & Denchev 2012).

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